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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/KR00/00792

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7 C25D 3/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 C21D 1/00, C21D 9/56, C25D 3/00, C25D 5/00, C25D 7/06,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 61-136634 A (KOBE SEIKOSHO) 24, JUNE, 1961	1
A	JP 61-157621 A (SHINITTETSU SEITETSU) 17, JULY, 1961	1
A	JP 61-158628 A (TOSHIBA CORP.) 18, JULY, 1961	1
A	JP 1-129996 A (KAWASAKI SEITETSU).23 MAY 1989	1

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

## \* Special categories of cited documents:

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Date of the actual completion of the international search

24 APRIL 2001 (24.04.2001)

Date of mailing of the international search report

25 APRIL 2001 (25.04.2001)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office  
Government Complex-Taejon, Dunsan-dong, So-ku, Taejon  
Metropolitan City 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

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Telephone No. 82-42-481-5525



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
14 February 2002 (14.02.2002)

PCT

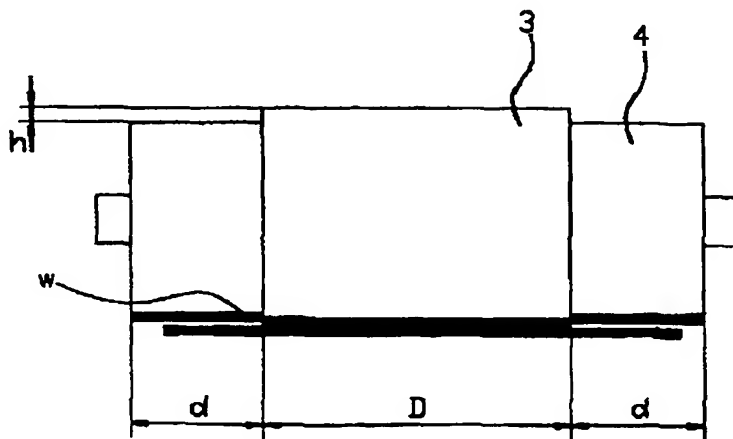
(10) International Publication Number  
**WO 02/12595 A1**

- (51) International Patent Classification<sup>7</sup>: **C25D 3/00** [KR/KR]; Kyosu-apt. 7-1502, Jigok-dong, Nam-Ku, Kyungsangbuk-do, Pohang 790-390 (KR). **LEE, Shi-Yeob** [KR/KR]; 1 Gyeodong-dong, Nam-ku, Kyungsangbuk-do, Pohang 790-300 (KR).
- (21) International Application Number: **PCT/KR00/00792**
- (22) International Filing Date: **24 July 2000 (24.07.2000)**
- (25) Filing Language: **Korean**
- (26) Publication Language: **English**
- (71) Applicants (for all designated States except US): **POHANG IRON & STEEL CO., LTD** [KR/KR]; 1 Gyeodong-dong, Nam-ku, Kyungsangbuk-do, Pohang 790-300 (KR). **POHANG RESEARCH INSTITUTE OF INDUSTRIAL SCIENCE & TECHNOLOGY** [KR/KR]; San 32, Hyoja-dong, Nam-ku, Kyungsangbuk-do, Pohang 790-330 (KR).
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- (81) Designated State (national): **US**.
- (84) Designated States (regional): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).
- Published:  
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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(54) Title: **METHOD OF REDUCING A BAND MARK OF AN ELECTROPLATING STEEL SHEET**



(57) Abstract: The present invention relates to a method of reducing a band mark on an electroplating steel sheet, which can also reduce plating defects and damages to the materials caused by the differences in the physical characteristics of composition materials of a conductor roll used during electroplating Zn or Ni onto a steel sheet. In other words, the present invention comprises ceramic coating portions of circular bands, placed respectively in a thin strip at the both edge regions of the metal band position at the central portion of a conductor roll. In this manner, the present invention has the effects of reducing a band mark on a plating steel sheet, and also suppressing the generation of static electricity by eliminating the level difference

between the conductive material (metal band portion) and the non-conductive material (rubber section). The present invention is also capable of extending the life of a conductor roll by enhancing the wear and corrosion resistances thereof.



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## METHOD OF REDUCING A BAND MARK OF AN ELECTROPLATING STEEL SHEET

Technical Field

5 The present invention relates to a method of reducing a band mark on an electroplating steel sheet, for enhancing wear and corrosion resistances of a conductor roll, which comprises minimizing the level difference between the conductive material (metal band portion) and the non-conductive material (rubber section) of the conductor roll used during the process of electroplating zinc (Zn) or nickel (Ni) onto the steel sheet.

10 Background Art

In general, a conductor roll (1) is an electric apparatus for plating a steel sheet, installed in electrolytic bath, which is immersed into the plating solution (L) with Zinc (Zn) or Nickel (Ni) as an anode, and the conductor roll itself as a cathode. By continuously inducing a steel sheet (S) in this manner, the conductor roll carries out electroplating as illustrated in FIG. 1.

15

Here, with respect to the conductor roll (1), if the entire portion of its surface consists of a conductive material, the roll itself becomes electroplated. As such, in order to plate the steel sheet while not plating the conductor roll in itself, the conductor roll (1) which is in direct contact with the steel sheet (S) is made out of a non-conductive material at the outer sections (d) of the conductor roll (i.e., both end portions of the cylinder).

20

In other words, as illustrated in FIG. 2, a conductor roll (1) comprises an inner section (D) in the central portion of the cylinder, and an outer section (d) at the either end portion of said inner section (D). The inner section (D) comprises a conductive material, such as steel or a metal material, having superior acid and corrosion resistances in a strongly acidic plating solution. The outer section (d) comprises a non-conductive material such as rubber. Meanwhile, the width of the conductive metal material at the inner section (D) of the conductor roll (1) should be less than the minimal width of the steel sheet (S) to be plated (i.e., generally lesser by 100 mm).

25

30 On the other hand, Japanese Patent No. 10,245,695 (September 14, 1998), as a means of enhancing corrosion and wear resistances of a conductor roll, teaches a method of spray-coating

the steel band portion with a mixture of nickel-based alloy and tungsten carbide (WC). Meanwhile, Japanese Patent No. 4,346,693 (December 2, 1992) teaches a method of enhancing corrosion and wear resistances by coating the cobalt or nickel-based alloy with ceramics of relatively superior electric conductivity (to the degree of carbides).

5

Moreover, as for the non-conductive material used in the outer section (d), which comprises the both end portions of the conductor roll (1), ebonite (i.e., polymer materials), multilastic, sponge, polyurethane, etc. are used.

10

Moreover, as for the plating solution for immersing the conductor roll (1) during the electroplating process, the temperature used therein is approximately 70°C. Due to the differences in the mutual thermal expansion coefficients as between the metal band portion (3) of the inner section (D) and the rubber section (4) of the outer section (d) at the temperature of the plating solution in use, the rubber section (4) is characterized by greater expansion as compared to the metal band portion (3).

15

Therefore, in consideration of the thermal expansion coefficient of the metal band portion (3) of the conductor roll (1) and that of the rubber section (4), the level difference (h) of the rubber section (4) is made in such a manner to be lower than the level difference of the metal band portion (3). In this manner, the level of the metal band portion (3) of the inner section (D) and that of the rubber section (4) of the outer section (d) are maintained at a certain level at the temperature of plating solution in use (approximately 70°C).

20

However, if the deflector roll (2), which pulls the plating metal sheet (S) in both directions, applies tension via the conductor roll (1), the plating metal sheet presses against the rubber section (4), which in turn results in deformation of the rubber section (4). In particular, depending on the quality of the material, the thickness thereof, and the degree of tension therein, the extent to which it presses against the rubber section (4) may vary.

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In other words, as shown in FIG. 2, as the load of the plating steel sheet (2) becomes directly concentrated on the ends of the metal band portion (3), it induces a curve deformation

(W), more severe than the level difference thereof (h). Consequently, a strip is formed (i.e., band mark) on the surface of the steel sheet (S) passing under the curve deformation region (W). This type of a band mark could be clearly confirmed with the naked eye and is one of the most severe defects of the plating steel sheet.

5

If the level difference (h) between the metal band portion (3) and the rubber section (4) is made to be smaller in order to reduce the band mark on a steel sheet (S), the load of the steel sheet becomes concentrated on the rubber section, and the frequency of occurrence of band marks is decreased. However, a gap is created between the conductive metal band portion and the plating steel sheet. Consequently, as shown in FIG. 4(a), static electricity (arc) is created therein.

Moreover, if static electricity is generated between the metal band portion and the plating steel plate, the metal band portion and the rubber section rapidly become damaged by static electricity. When this type of situation occurs, an abrasion work on the conductor roll must be immediately carried out once again.

Consequently, if the level difference (h) between the metal band portion (3) and the rubber section (4) is made to be smaller, the frequency of occurrence of band marks is reduced although there is a problem associated with the reduction of life of the conductor roll due to the premature damage to the metal band portion and the rubber section.

In this regard, in consideration of these problems caused by the aforementioned structural defects of a conductor roll, the present invention was devised with an objective of providing a means of eliminating a band mark on a steel sheet, which uses a non-conductive ceramic material, instead of a polymer material with a large thermal expansion coefficient.

In achieving the aforementioned objective, the present invention comprises ceramic coating portions of circular bands, placed respectively in a thin strip at the both edge regions of the metal band portion at the central portion of a conductor roll. As such, the present invention has the effects of suppressing the occurrence of static electricity and also reducing a band mark on an electroplating steel sheet by eliminating the level difference between the conductive

material (metal band portion) and the non-conductive material (rubber section) thereof. Furthermore, the present invention is capable of extending the life of a conductor roll by enhancing the wear and corrosion resistances thereof.

5 Brief Description of Drawings

FIG. 1 is a sectional structural diagram of a general electroplating conductor roll as installed.

FIG. 2 is a lateral structural diagram of a conventional conductor roll.

10

FIG. 3 is a structural diagram of a conductor roll for reducing a band mark according to the embodiment of the present invention.

15

FIGS. 4(a) and 4(b) are structural diagrams, which compare the embodiment of prior art with that of the present invention.

Disclosure of Invention

The method of reducing a band mark on an electroplating steel sheet according to the present invention is described as below with references to the attached figures.

20

The present invention comprises ceramic coating portions of circular bands, placed respectively in a thin strip at the both edge regions of the metal band portion (10) at the central portion of a conductor roll (1). At the outer side of said ceramic coating portion (20), there is a conventional rubber section (30). The width of a ceramic coating portion (20) is approximately more than 10 mm, or more preferably, lesser than the width of the electroplating steel sheet (S) by approximately 10 mm.

25

In other words, if the length of the metal band portion (10) is  $x$  mm, and the width of the plating steel sheet (S) is  $y$  mm, the ceramic coating portion (20) should be coated with a width ( $d'$ ) between  $(x+10)$  mm at minimum and  $(y-10)$  mm at maximum.

30

According to the aforementioned method, if there is no level difference between the conductive metal band portion (1) and the nonconductive ceramic coating portion (20) at room temperature, the level difference does not occur even at the temperature in use (approximately 70°C). Further, since the two elasticity coefficients are similar, the level difference does not occur due to the pressing by the plating steel sheet. Accordingly, in such cases, static electricity does not occur, and neither does a band mark.

Although there is a level difference at a certain height as between the ceramic coating portion (2) and the rubber section (30), the generation of static electricity is prevented at the source in such circumstances by reducing the level difference as compared to that of the prior art.

In other words, if the level difference of a ceramic coating portion (20) is made in such a way to be slightly higher or at flush with the rubber section (30), the load of the plating steel sheet (S) becomes concentrated onto the rubber section (30) having weak physical properties (i.e., lower elasticity coefficient), which results in a significant reduction of a band mark on a steel sheet. Further, by concentrating the load of the electroplating steel sheet (S) onto the rubber section, the weakness of the ceramic coating portion (20) is offset to the same extent, with the result of preventing damages to the ceramic coating portion.

If the width (d') of a ceramic coating portion (20) is less than 10 mm, there is a risk that a gap would form the space between the steel sheet (S) and the metal band portion (10) when the level difference (h) between the metal band portion (10) and the ceramic coating portion (20) is large. Through this type of a gap, static electricity would occur therein.

Moreover, if the gap between the ceramic coating portion (20) and the minimal width of a steel sheet is less than 10 mm, the seal between the rubber section (30) and the electroplating steel sheet (S) becomes incomplete, and the plating solution seeps through the gap, which in turn results in contamination of the plating steel sheet.

On the other hand, as for the coating method for the ceramic coating portion (20), the spray-coating method is used. It is preferable to carry out the coating by means of a plasma



sprayer in order to minimize such conditions as post-coating separation.

Further, as for the coating materials for the ceramic coating portion (20), it is preferable to use oxide-based ceramics with not so good electric conductivity, such as alumina ( $\text{Al}_2\text{O}_3$ ), zirconia ( $\text{ZrO}_2$ ), and chromia ( $\text{Cr}_2\text{O}_3$ ). In particular, as compared to electric non-conductivity of oxidized ceramics sintered at the same thickness, there is an improvement in electric non-conductivity of oxidized ceramics after spray-coating.

Approximately 3-40wt% of titania ( $\text{TiO}_2$ ) is added to the aforementioned coating material of a ceramic coating portion (i.e., alumina, zirconia, chromia). By adding more titania as such, the toughness of the coating material improves. As compared to pure zirconia, the zirconia used herein is a partially stabilized zirconia with a small amount of added  $\text{MgO}$ ,  $\text{CeO}_2$ ,  $\text{Y}_2\text{O}_3$ , etc.

As for the aforementioned material, which is in a form of powder, a comparatively fine powder should be used with a particle size of approximately  $5\sim 50\ \mu\text{m}$ . Depending on the particle size of the powder in use, the porosity and roughness of the coating may vary, and by using fine powder, the porosity and roughness can be lowered to the maximum.

Moreover, since there are approximately 5-10% of micro-pores still remaining on the ceramic coating even after lowering the porosity, a sealing treatment is carried out with a material (e.g., urethane or epoxy), which can tolerate the acidic plating solution at the temperature in use. There, only if the plating solution does not seep through the coating layer, can it prevent contamination of a plating steel sheet, even after replacing the plating solution.

Preferably, the thickness of the ceramic coating portion (20) should be  $0.2\sim 2\ \text{mm}$ . If the thickness of the ceramic coating portion (20) as coated is  $0.2\ \text{mm}$  or less, it becomes easily worn out due to the deterioration of electric non-conductivity, which in turn results in inconvenience of re-coating work within a short period of time. On the other hand, if the thickness as coated is  $2\ \text{mm}$  or more, it is characterized by deterioration of wear resistance with easy cracking due to the deterioration of bonding force of the coating layer.

As for the ceramic spray-coating, there is a deterioration of bonding force in the case of direct coating with the metals such as steel. Accordingly, in using the method of spray-coating, the metal coating is first carried out, followed by ceramic spray-coating. As for spray-coating the metals, it is preferable to coat it by using a plasma or high-speed sprayer.

5

Meanwhile, by using the same coating material as the metal material used in the metal band portion (10), the differences in the thermal expansion coefficients can be minimized, with the result of preventing separation and extending the life of the coating.

10 For the following reasons, it is preferable to set the thickness of the metal coating at 50~200  $\mu\text{m}$ . If the thickness of the coating is 50  $\mu\text{m}$  or less, the effect of the metal-bonded coating layer becomes insignificant. If the thickness of the coating is 200  $\mu\text{m}$  or more, there is a decline in economical efficiency.

#### 15 Best Mode for Carrying Out the Invention

In the simulator tester, hastelloy (H) was used as a material for the metal band portion (10) of a conductor roll (1), and multilastic (M) was used as a material for the rubber section (30). With respect to the ceramic coating portion (20) after spray-coating according to the present invention, the degree of formation of a band mark on a plating steel sheet was measured by  
20 using a gloss measurement device.

Meanwhile, the length of the metal band portion (10) using hastelloy was 700 mm, and the minimal width of a plating steel sheet (S) was 800 mm. As for the spray-coating on the ceramic coating portion (20), the test was carried out with its width of 25 mm.

25

As for the coating material of the ceramic coating portion (20), the material of  $\text{Al}_2\text{O}_3$ -13% $\text{TiO}_2$  was used. There, the powder with a particle size of 5-30  $\mu\text{m}$  was used to coat the ceramic coating portion (20) by means of using a plasma sprayer. The metal-bonded coating layer was coated with a hastelloy material by means of using a high-speed sprayer.

30

As typically shown in FIG. 4, the metal-bonded coating layer was finished off at a

thickness of approximately 100  $\mu\text{m}$ , and the ceramic coating layer at approximately 600  $\mu\text{m}$ . After spray-coating, a commercially sold sealing agent was sprayed thereto. Then, after the abrasion work, the testing was carried out with respect to the plating steel sheets.

5 In the prior art, if the multilastic material is on top of the hastelloy material during the process of using a conductor roll (1), it generates static electricity. As such, under the condition of hastelloy being on top, the level difference as between hastelloy and multilastic was set to equal 0.4 mm.

10 In the present invention, it was made without any level difference between the hastelloy and the multilastic. With the multilastic material on top of the ceramic coating, the level difference was set to 0.1 mm.

Table 1. Measurement of the Degree of Band Mark Formation

Type of Plating Steel Sheet	Scores on the Band Marks					
	A	B	C	D	E	F
Prior Art	4.1	4.1	3.5	4.2	3.8	4.3
Present Invention	1.0	0.9	0.8	0.4	0.1	0.2

15 Table 1 shows the scores on the band marks according to the respective plating steel sheets and the thickness thereof in the simulator tester. As shown in Table 1, the higher the scores on the band marks, the more severe the band marks became with exasperating differences from the normal sections.

20

In the present invention, it showed a significant reduction of a band mark, even to the degree of posing difficulties in identification with the naked eye. Furthermore, there were no problems associated with occurrence of static electricity during its use. While the rubber material was easily worn out during the abrasion work on a conventional roll, the problem was effectively solved by preventing such premature wearing-out by means of ceramic coating, with the effect of extending the life of a roll.

25

### Industrial Applicability

5 According to the method of reducing a band mark on an electroplating steel sheet according to the present invention, it prevents generation of static electricity by minimizing the level difference between the conductive material (metal band portion) and the non-conductive material (rubber section). In this manner, the frequency of occurrence of band marks on plating steel sheets is reduced. Moreover, the present invention has the effects of enhancing wear and corrosion resistances, which in turn results in extending the life of a plating apparatus.

## CLAIMS

What is claimed is:

- 5        1. A method of reducing a band mark on an electroplating steel sheet, in relation to manufacturing a conductor roll used in electroplating a steel sheet, which comprises ceramic coating portions (20) of circular bands, placed respectively in a thin strip at the both edge regions of a metal band portion (10) at the central portion of a conductor roll (1), and a rubber section (30) at the outer side of said ceramic coating portions (20).
- 10       2. The method of reducing a band mark on an electroplating steel sheet according to Claim 1, wherein said ceramic coating portions (20) are coated at 0.2~2 mm by means of spray-coating, using a material of oxide ceramics, which is selected from the group consisting of zirconia, alumina, and chromia, in powder with a particle size of 5~30 μm.
- 15       3. The method of reducing a band mark on an electroplating steel sheet according to Claim 2, which comprises carrying out a plasma spray-coating by adding 3~40wt% of titania to alumina or chromia in order to increase the toughness of said ceramic coating portions (20), and then adding a small amount of CeO<sub>2</sub>, Y<sub>2</sub>O<sub>3</sub> or MgO to zirconia.
- 20       4. The method of reducing a band mark on an electroplating steel sheet according to Claim 1 or 2, wherein the width of said ceramic coating portion (20) is 10 mm or more at minimum, in between the conductive metal band portion (10) and the non-conductive material, with the maximum width of the coating having a difference of 10
- 25       mm or more than the width of a plating steel sheet.
- 30       5. The method of reducing a band mark on an electroplating steel sheet according to Claim 1, which comprises carrying out a sealing treatment, after ceramic coating, on the ceramic coating portions (20) at the both edge regions of the metal band portion (10), using a sealing agent of urethane or epoxy, followed by abrasion work.

6. The method of reducing a band mark on an electroplating steel sheet according to Claim 1, which comprises spray-coating at a thickness of 50~200  $\mu\text{m}$ , using a metal-base material prior to coating the ceramic coating portion (20).
- 5 7. The method of reducing a band mark on an electroplating steel sheet according to Claim 6, which comprises using a plasma spray method or a high-speed spray method, using a metal-based material which is the same conductive metal material as that of the metal band portion (10).

## ABSTRACT

The present invention relates to a method of reducing a band mark on an electroplating steel sheet, which can also reduce plating defects and damages to the materials caused by the differences in the physical characteristics of composition materials of a conductor roll used during electroplating Zn or Ni onto a steel sheet. In other words, the present invention comprises ceramic coating portions of circular bands, placed respectively in a thin strip at the both edge regions of the metal band portion at the central portion of a conductor roll. In this manner, the present invention has the effects of reducing a band mark on a plating steel sheet, and also suppressing the generation of static electricity by eliminating the level difference between the conductive material (metal band portion) and the non-conductive material (rubber section). The present invention is also capable of extending the life of a conductor roll by enhancing the wear and corrosion resistances thereof.

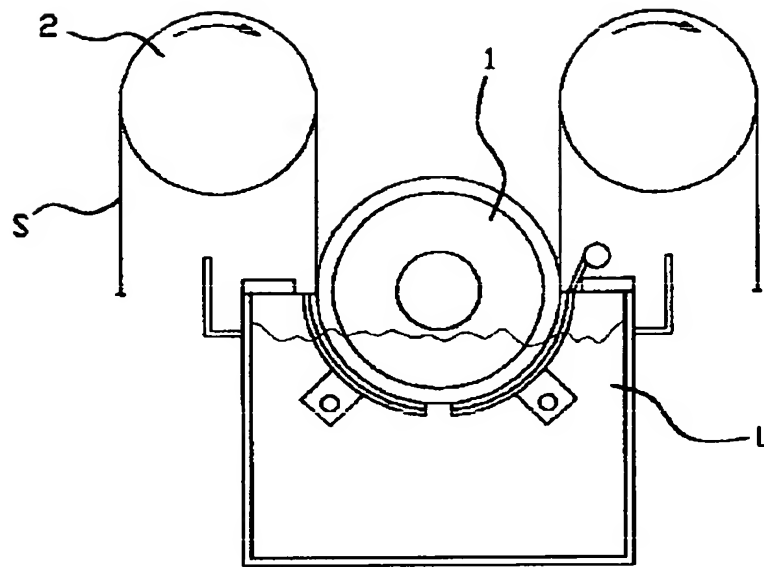
**FIG. 1**



FIG. 2

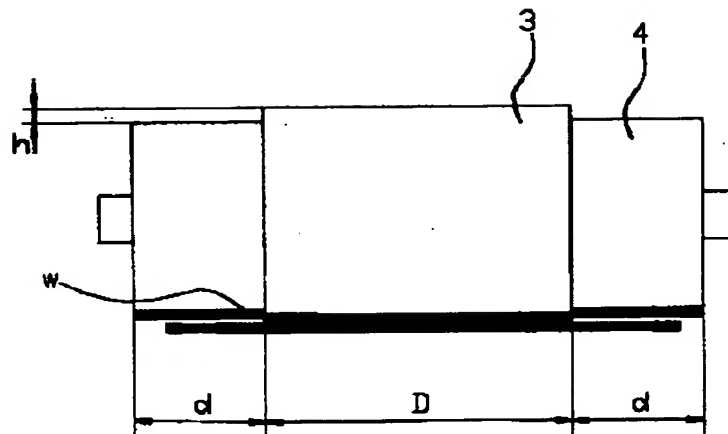
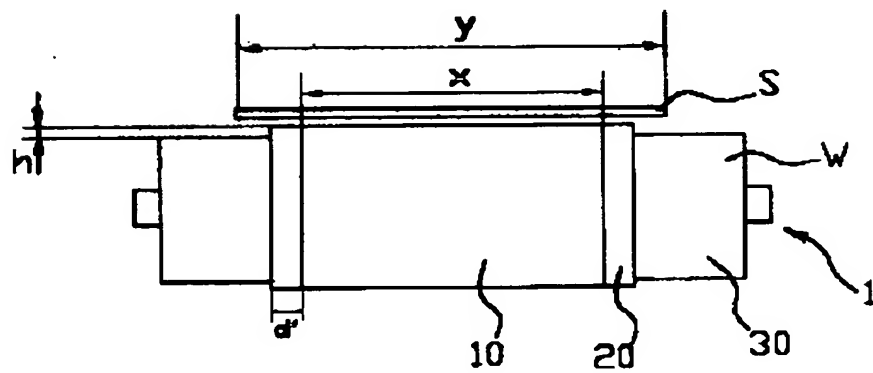
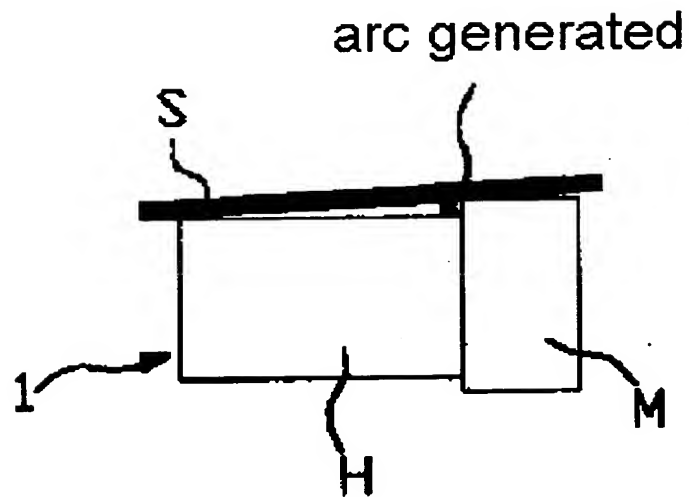


FIG. 3



**FIG. 4(a)****FIG. 4(b)**